ELK MOVEMENTS AND HABITAT USE ON A MANAGED FOREST IN NORTH-CENTRAL IDAHO

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ABSTRACT

Seasonal elk movements, distribution and habitat preferences were investigated on a managed forest in north-central Idaho from June 1974 through August 1977. Ground and aerial surveys provided 289 visual sightings of 1,088 marked and unmarked elk, and radio telemetry provided 900 relocations of 9 radio-collared elk. We estimated that about 300 elk summered on the study area. The observed cow:calf:bull ratio averaged 100:52:19 during the study.

Elk summering in Newsome and Leggett Creek drainages were migratory animals from at least four distinct winter ranges in the Meadow, Cougar, Silver and Clear Creek drainages. Distances between winter and summer ranges varied from 6 to 33 km. Elk commonly traveled through low areas when crossing major hydrologic divides. Spring and fall migration routes were essentially similar and the same corridors were used each year.

Fall and spring migrations were correlated with snow conditions and temperature, and the influence they had on ease of travel and forage availability. Elk occasionally reversed their fall migration and returned to summer activity areas in response to milder weather and a reduction in snow depths. Elk that frequently were associated together on summer and winter ranges migrated along the same routes, but not in the same groups nor at the same time.

During spring migration, bulls showed highly erratic and rapid movements over long distances. Cow movements, although just as abrupt and swift, were restricted to traditional migration routes. Three cows moved directly to summer range prior to calving, while two other cows calved close to winter ranges.

Fidelity of elk to summer and winter areas of former use was strong for cows and weak for bulls. Cow elk occupied summer activity ranges from as early as mid-May to as late as the end of December, averaging 184 days. Size of activity areas varied among individuals and between years, ranging from 223 to 2,209 ha. Elk occupied winter range from as early as mid-November to as late as early June; average length of stay ranged from about 125-187 days.

While on summer activity areas elk selected for elevations of 1,524 to 1,676 m from an available range of 1,158 to 2,173 m, and for relatively level (less than 20% gradient) topography.

Old-growth grand fir associated with poorly drained, cool, moist land types were important habitat features during late summer and early fall. Clearcuts received greatest use in spring, early summer and late fall. When using clearcuts, elk selected areas where slash was removed by broadcast burning, and areas within 92 m of timber.

Disturbance from human activity was an important factor influencing elk distribution in our study. We observed displacement of elk from hunting, logging and motor vehicles. Degree of displacement appeared to be related to proximity, intensity and duration of disturbance.

Access roads for timber harvest strongly influenced elk hunter and harvest distribution. A greater harvest rate was evident for animals within 800 m of a road. Results from a questionnaire indicated that many sportsmen favored road closures.

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Photo Credits

Cover photo of a cow elk in a Newsome Creek clearcut by D.J. Herman.

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All other photos by T.A. Leege.

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INTRODUCTION

The accelerated timber harvest and increased accessibility of our national forests have substantially altered elk summer habitat in Idaho and other western states in recent years (Black et al. 1976, Lyon 1976, Perry and Overly 1976, Ward 1976, and Thiessen 1976). Our study area in northern Idaho has been subjected to logging activity since 1960, but still supports a huntable elk *(Cervus elaphus nelsoni)* population. Concern about the future of this elk population and how it might be affected by additional logging and access is what prompted this study. Our objective was to document relationships between elk and their existing habitat in order to assess impacts of management activities and provide recommendations for coordinating elk habitat requirements with other forest resource demands.

STUDY AREA

Newsome and Leggett Creeks are tributaries of the South Fork of the Clearwater River flowing through north-central Idaho (**Fig. 1**). The drainages lie within the Elk City Ranger District, NezPerce National Forest. The 19,595 ha (48,420 acres) area is 20.8 km long and 13.6 km wide at its greatest dimensions. Topography is moderately rolling except for some granitic outcrops along the western edge. Elevations vary from 1,158 to 2,173 m (3,800 to 7,127 ft). The area is characterized by an abundance of springs, seeps, intermittent and perennial streams. Precipitation is estimated to average 102 cm (40 in) annually with 60% arriving as snow between October and April (Layser et al. 1975). The entire area is elk, moose and deer summer range and some portions are also winter range.

Over 50% of the area is covered by mature and overmature climax grand fir *(Abies grandis)* forest. Grand fir/Queencup *(Clintonia uniflora)* is the dominant habitat type. Drier sites support a grand fir/beargrass *(Xerophyllum tenax)* type. Subalpine fir *(Abies lasiocarpa)*/Queencup and subalpine fir/false huckleberry *(Menziesia ferruginea)* are common types along stream courses and in other cool, moist areas. Other habitat types present that are minor in respect to the amount of the area they occupy are listed in Appendix A. The habitat type classification system followed here is that of Pfister et al. (1974).

A Pacific yew *(Taxus brevifolia)* community is common within both grand and subalpine fir habitat types (Sedge *(Carex spp.)* meadows and other riparian plant communities occur along streams and around other wet areas. Alder *(Alnus sinuata)* glades are also common in moist, cool areas. A few small, dry mountain meadows occur primarily between the 1,676 and 2,174 m elevational range. There are some small mature and immature lodgepole pine *(Pinus contorta)* and Douglas fir *(Pseudotsuga menziesii)* stands that resulted from wildfires. However, the area has not experienced any major wildfires since 1900.

Many old-growth timber stands support a lush understory plant community. Sunlight filtering through the open canopies of the old stands stimulates a flourishing growth of forbs, grasses and shrubs not found under younger, less open stands.

Logging since 1960 has removed timber from about 3,304 ha or 17% of the total area. About 98% of the logged area was clearcut and 2% was harvested by other methods. Zamora (1975) provides an excellent discussion of secondary plant succession on clearcuts in grand fir habitat in north-central Idaho. Herman (1978) describes species composition of elk diets in Newsome Creek during summer.

Road surface and right-of-way clearing occupy 167 ha, about 1% of the study area. Eighty-two kilometers of primary, 133 km of secondary and 334 km of primitive roads traverse the area at a density of 2.8 km of roads/km^2 (4.5 mi/sq mi).

The Forest Service has provided for one annual grazing allotment in the area since 1940. Grazing use has varied from 200 head for 800 animal unit months/year to the present 120 head for 452 aum's.

METHODS

Ground Observations

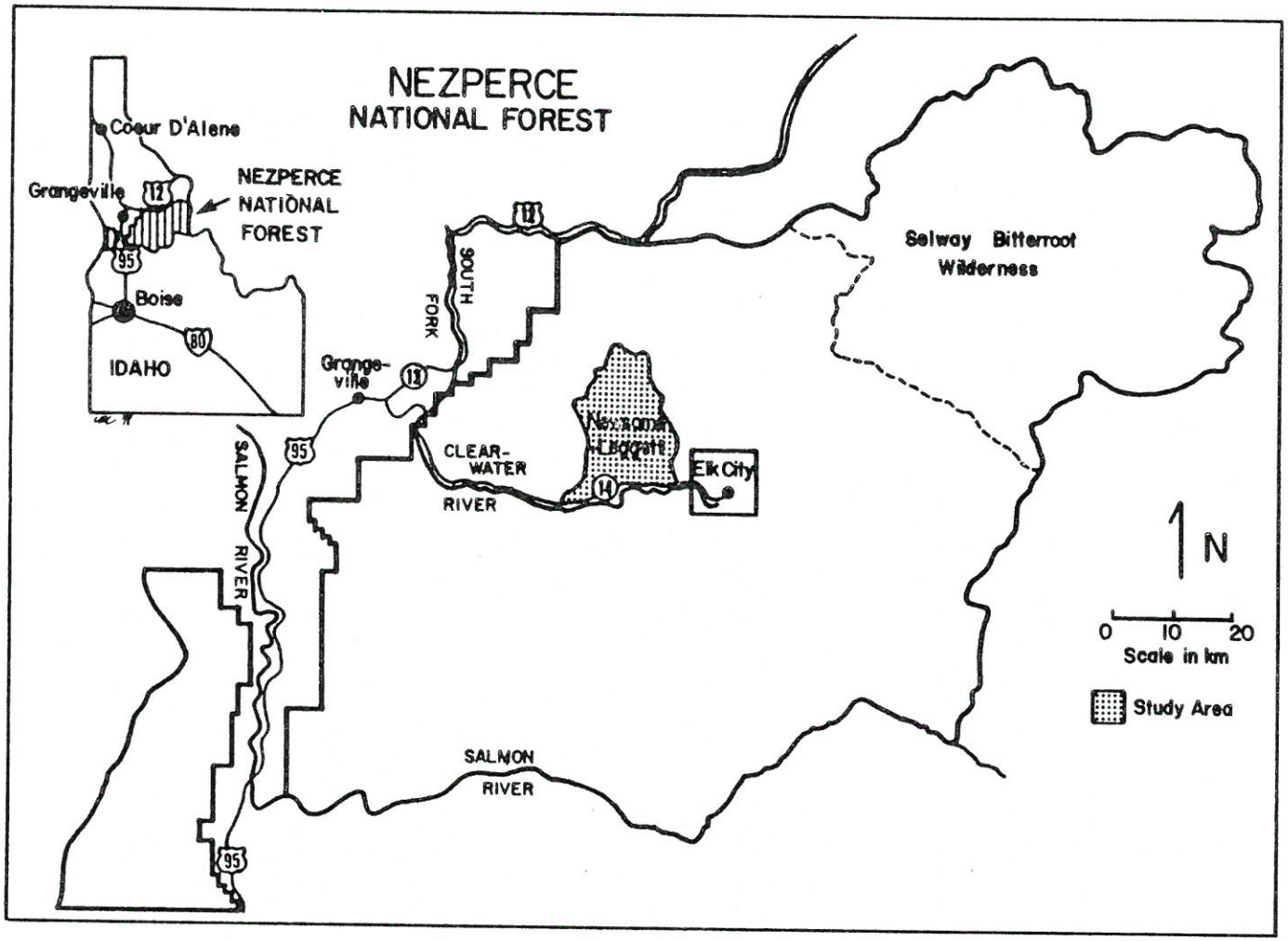
Ground observation of unmarked elk was the primary method of field study in 1974. Sixteen observation routes over roads and trails were traveled 80 times for 1,280 km from 20 June through 31 August. Observations were made twice daily from one hour before sunrise until mid-morning and three hours before sunset until one hour after sunset. Eleven routes were traveled by trail bike or truck and five by foot.

Radio Telemetry

Radio telemetry was used to gather data on elk movements and habitat use from August 1975 through 8 September 1977. Nine elk were collared with pulsing radio transmitters while on summer range in 1975. Elk were either trapped in corral-type panel traps baited with salt or darted with an immobilizing drug from a helicopter. All elk were immobilized with powdered succinylcholine chloride.

Radio locations were obtained from a Cessna 185 equipped with two 3-element Yagi antennas attached to the wing struts. Flights were scheduled once daily five days a week at various times during daylight hours from August through November 1975. An effort was made to time flights equally among morning, afternoon and evening periods. Flights were made only once a month while elk were on winter range from December 1975 through April 1976. Beginning in May 1976 flights were scheduled every other day at various times during daylight hours until August 1976. Flights were made only twice a month thereafter, until the end of the radio-tracking study on 8 September 1977.

Figure 1. Newsome Creek-Leggett Creek study area in north-central Idaho near Elk City.



Observations of unmarked elk were recorded during all flights.

Activity areas for collared elk were evaluated in relation to habitat attributes. Activity area, as used in this study, was defined as that area used by an elk during its normal activities on a seasonal range. The boundaries were delimited by an irregular polygon formed by connecting the outermost radio locations (Mohr 1947). Radio locations representing movements between seasonal ranges were not considered as part of an activity area.

Irregular areas with shapes that corresponded to the actual outline of important habitat attributes were then delineated within the perimeter of each summer activity area. Habitat attributes considered for each activity area and elk radio location included: elevation, exposure, slope, habitat type, cover and land type. We also analyzed distributions of elk observations with respect to distance to the nearest road and the age, size and treatment of cutting units within summer activity areas.

Road Classification

Seven traffic counters were monitored from 12 July to 7 October 1974. Road classifications used in this paper were categorized on the basis of the number of vehicles/day use as well as the type, size, condition and maintenance of the road bed. Main roads were traveled by an average of 20 (range 5-71) vehicles/day in the absence of logging traffic, and an average of 58 (range 10-185) vehicles/day with logging traffic. Main roads were graveled one and one-half lanes wide or wider. They were improved all-weather roads in good condition and received regular maintenance.

Secondary roads were traveled by an average of 2 (range 0.3-5) vehicles/day. They were either gravel or dirt and one or one and one-half lanes wide. Secondary roads were generally in fair condition and received irregular maintenance.

Primitive roads were single lane unimproved dirt roads in fair or poor condition. They were traveled less than once a day and were accessible only to trail bikes, ATV's and 4-wheel drive vehicles. Primitive and secondary roads were fair weather roads.

Sport Hunting Information

During October 1975 weekly field checks were made to gather elk harvest information and to distribute hunter questionnaires to investigate hunting activity. Additional data on elk harvest were obtained from hunter report cards and check station records.

RESULTS AND DISCUSSION

Elk Capture and Telemetry Information

Four cows and 1 bull were captured on summer range in Newsome Creek in panel traps during June 1975. Three cows and 1 bull in Newsome Creek were darted from a helicopter in July 1975. All elk capture sites were in or adjacent to clearcuts.

Capture sites for 6 cows and 1 bull fell within the boundaries of the summer activity areas delineated for each elk. The other 2 elk were captured outside their activity ranges. Cow 10 was darted in a clearcut near the headwaters of Leggett Creek about 2.8 km S of the nearest radio fix in her summer activity area in Newsome Creek (**Fig. 2**). Bull 2 was captured in a trap in a clearcut in Newsome Creek approximately 10 km SSW of its nearest radio fix on summer range in O'Hara Creek.

Approximately 900 radio locations were recorded for 9 elk during 121 flights between 1 August 1975 and 17 April 1978 (**Table 1**). Seventeen percent of the fixes were also visual sightings. About 700 radio locations were used to evaluate habitat preferences within elk summer activity areas. The other 200 radio fixes were obtained during spring and fall migration and while elk were on winter range.

Additional data were gathered from 72 ground observations of 257 unmarked elk in 1974 and 217 ground and aerial observations of 831 marked and unmarked elk in 1975-76.

Herd Structure

The observed cow:calf:bull ratio averaged 100:52:19 during the four years of this study. We estimated that approximately 300 elk summered on the study area.

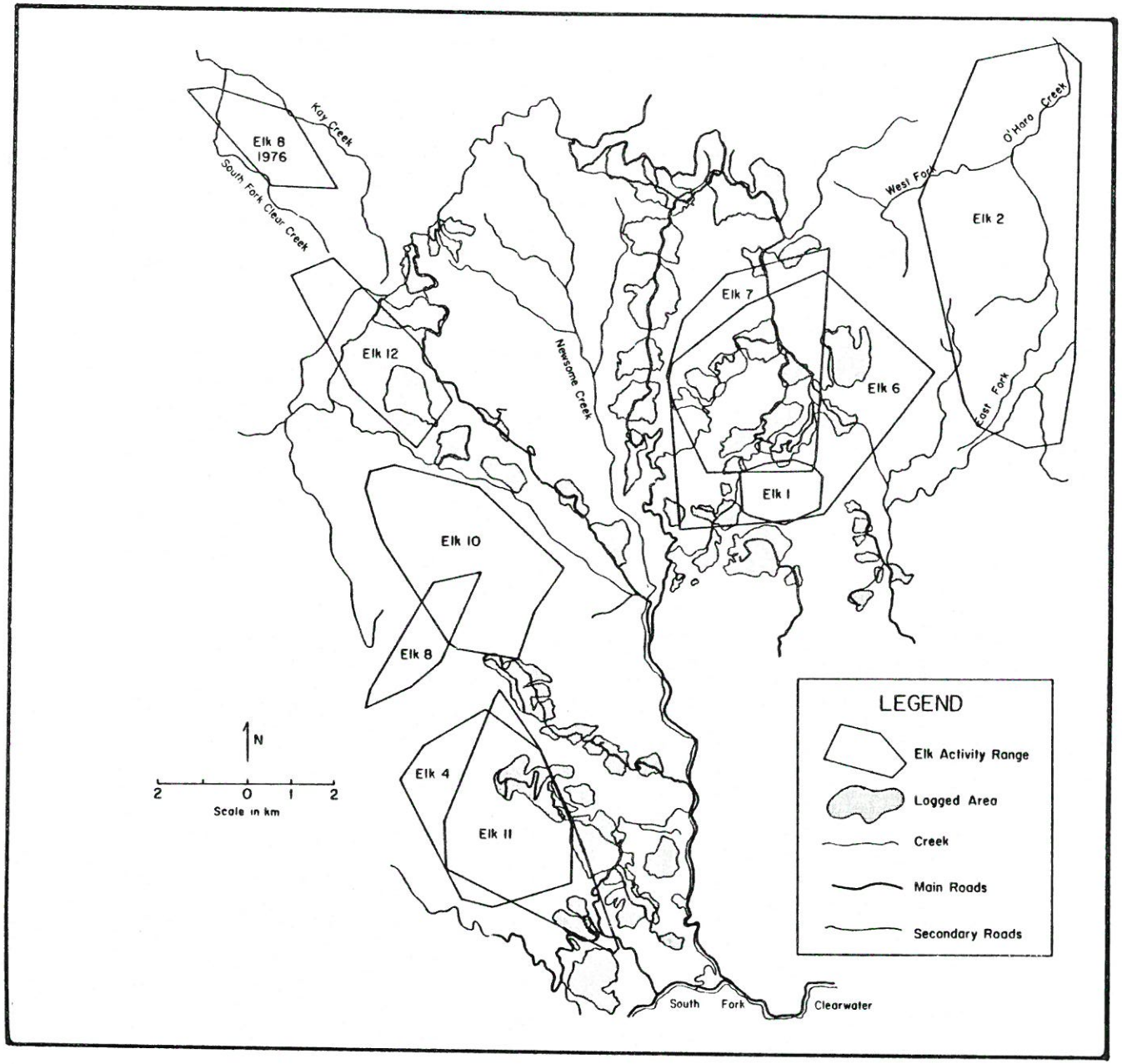
Sixty-three percent, 33% and 4% of all elk classified (N = 454) were cows, calves and bulls, respectively (**Table 2**). Bulls were consistently less observable during the study. Elk observations and group sizes were low in late May and early June because of calving, but increased after mid-June. The greatest numbers of elk were observed in July and August when elk groups were largest (**Table 2**). A dramatic drop in elk observations and group size occurred in September and October. Numbers of elk observed and group sizes increased with snow accumulation in November.

Herd composition was highly variable throughout the study, with 2 or 3 collared elk sometimes located in the same group one day and in different groups the following day.

Summer Activity

Fidelity. All 7 radio-collared cow elk exhibited fidelity to distinct activity areas while on summer range (**Fig. 2**). Summer activity area as defined in this study referred to a common area of activity used from spring through fall. Fidelity occurred despite harrassment and changing weather and phenological conditions between seasons and years. Three cows were located on the same activity areas during three consecutive years. Two cows that were radio tracked only two consecutive years used the same summer areas both years. The amount of overlap between 1975 and 1976 summer activity areas for 4 cows is presented in **Table 3**. The

Figure 2. Summer activity areas for 9 radio-collared elk in relation to existing roads and logged area. Activity areas are composites of two summers use for elk 4, 6, 7 and 10.



other 2 cow elk were tracked for only six months and occupied distinct activity areas from August through November 1975.

Fidelity to distinct areas while on summer range was not as strong for bulls. Both bulls showed fidelity to an area from August through September 1975. However, in October, they exhibited erratic movements away from their activity areas in response to hunter disturbance. Neither bull returned to use its August-September range in 1975. Four cows also moved off their activity areas in October 1975 in response to hunter disturbance, but all returned to their areas later in the same month. They continued to use their areas into December until forced to migrate to winter range.

In June 1976 both bulls returned to their 1975 summer areas, but they did not stay long. Instead, they both established new summer ranges outside the areas used in 1975. Both bulls showed loose fidelity to their new summer areas prior to loss of radio contact with them.

Bull 8 moved 10 km NNW of his 1975 summer activity area in late June 1976. He established a new activity area in this location (**Fig. 2**). He was still using the area when we lost radio contact with him on 6 August 1976. The bull was familiar with the area prior to June 1976 since it was along his migration route to and from winter range.

Table 1. Summary of radio-tracking of elk activity.

Age	Sex	Collar no.	Collared interval[a]	No. of days instrumented	No. of days tracked	No. of radio locations[b]	Notes
Adult	F	1	6/17 - 11/30/75	167	68	68	Transmitter failure
Adult	F	4	6/22 - 4/17/78	1029	121	120	Still transmitting
2 yr.	F	6	6/26 - 4/17/78	1025	121	121	Still transmitting
Adult	F	7	6/26 - 9/8/77	804	119	119	Lost contact
Adult	F	10	7/9 - 3/11/77	611	118	113	Died
Adult	F	11	7/9 - 11/30/75	145	68	67	Lost contact
Adult	F	12	7/9 - 7/2/76	359	80	79	Transmitter failure
1 yr.	M	2	6/21 - 10/6/76	472	107	102	Lost collar
2 yr.	M	8	7/8 - 7/29/76	387	102	98	Lost contact

[a]All elk were collared in June and July 1975.

[b]Includes only locations which were thought to be highly accurate.

Table 2. Elk observed in clearcuts.

	Individuals					Group Size		
Period	Cows	Calves	Bulls	Unk[a]	Total	No. of Groups	Mean	Range
Jun. 1976	43	15		30	88	18	5	1-18
Jul. 1974 & 76	114	62	5	102	283	37	8	1-22
Aug. 1974 & 75	93	54	12	80	239	32	8	1-22
Sept. 1975	3	2		12	17	4	4	1-6
Oct. 1975	8	3		10	21	6	4	1-6
Nov. 1975	23	15	2	113	153	23	7	1-16
Total	284	151	19	347	801	120	6	1-22

[a]Unable to identify.

Table 3. Area of summer activity ranges of elk based on distribution of radio fixes.

Sex	Elk no.	Area encompassed by travels in hectares			% of 1975 area occupied in 1976
		1975	1976	Composite[a]	
Females	1	223			
	4	1036	724	1190	59
	6	2209	1072	2382	45
	7	1278	977	1448	69
	10	701	846	1157	65
	11	1115			
	12	659			
	Avg.	1032	905	1544	60
Males	2	828	1965	2610	63
	8	315	381	696	0
	Avg.	572	1173	1653	32
All Elk	Avg.	929	994	1581	50

[a]Total range occupied during two summers.

Table 4. Monthly snow depth (cm) at Elk City (1,237 m elevation), Idaho County, Idaho, during the fall and winter of 1975-76 and 1976-77.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1975-76	9.9/20.3[a]	20.3/50.8	28.7/61.0	69.1/101.6	65.3/81.3	67.1/73.7	22.6/61.0
1976-77	--	--	10.5/25.4	33.0/61.0	23.1/30.5	34.7/61/0	24.4/55.9

[a]Average daily snow depth/maximum depth on ground during the month. Total snow depth of all days was divided by the number of days with snow on the ground to determine average daily snow depth.

Bull 2 also moved off his 1975 summer activity area in late June 1976 after occupying the area only nine days. From July through September 1976 he moved through a large activity area that included 63% of his 1975 summer area, as well as all of his 1975-76 winter range. The bull was still using this area when his collar snapped off in early October.

Use Period. Elk occupied summer areas from as early as mid-May to as late as the end of December. Four cows tracked through the complete year in 1976 stayed on their activity areas from 153 to 214 days. Three cows (4, 6 and 7) arrived on their summer areas on 21 May and the fourth cow (10) on 25 June. Cows 4, 6 and 7 were on the same summer areas by 31 May 1977. Cow 10 was not tracked in the spring of 1977.

The earliest one of these cows left its summer area in 1976 was by 31 October. Another cow left its area by 30 November and the other two left by 31 December. In 1975, the earliest one of these cows left its activity area was again 31 October. Another cow left its area on 21 November and the other two left by 30 November. Three other cows tracked only in 1975 left their summer areas on 18 October, 21 November and by 30 November.

The total length of time bulls stayed on summer areas was not determined because neither bull was tracked for a complete year. Both bulls left their 1975 summer activity areas earlier than any of the cows. Bulls 2 and 8 moved off their areas on 1 and 7 October, respectively. In the spring of 1976, both bulls arrived on their summer activity areas later than any of the cows, except one. Bull 8 arrived on 27 June and bull 2 arrived between 9 and 23 June. Their earlier departure dates in 1975 and later arrival dates in 1976 indicated that bulls spent less time on summer areas than cows.

Size. Size of summer areas varied greatly among individuals and between years, ranging from 223 to 2,209 ha (**Table 3**). Variability in activity range size should be expected, since individuals occupying different areas would not find the same distribution of environmental needs within their respective area. The sex, age, reproductive status, previous experience and habits of individuals also undoubtedly influence activity area size. In our study, the youngest cow (6) and youngest bull (2) had the largest composite activity areas (**Table 3**).

Fall Activity

All collared elk migrated off the study area and onto winter ranges in different drainages. The onset of migratory activity was in response to snowfall and snow accumulation on summer range. Monthly snow depth for the fall and winter of 1975-76 and 1976-77 at an elevation of 1,237 m at the nearest weather station, 24.2 km ESE of the center of the study area, in Elk City, Idaho County, Idaho, is reported in **Table 4**.

Migration Restlessness. In 1975, seven of nine collared elk exhibited obvious migratory restlessness in response to the first snowstorm of the year between 22 and 28 October. At Elk City approximately 20 cm was the maximum depth of snow on the ground during this period. Snow depth averaged about 30 cm greater on the study area because of higher elevations.

Elk started moving toward winter range in the following sequence: 1 cow on 24 October; 1 cow and 1 bull on 28 October; and 4 cows on 1 November. One cow not showing migratory tendencies centered her activity around large clearcuts within her summer range following the storm. From the day after the storm on 29 October, through 21 November, the last day this cow was located on her summer area, she was always located in or adjacent to a clearcut or natural opening. Similar movements were observed for bull 2 during the storm. He confined his activity to a broad ridge of old-growth timber about 0.6 km from a large clearcut from the last day of the storm through 4 November.

A reversal in fall migration occurred when mild weather followed the October snowstorm. Four cows returned to their summer activity areas within a week after the storm. All 4 animals centered their activity around clearcuts on their summer ranges during November. Two cows continued to use their summer areas until 20 November when they dispersed to winter range. The other two left for winter range between 22 November and 5 December.

The 2 cows (1 and 10) and 1 bull (8) that did not return to their summer ranges after the storm stayed in "holding areas" for varying lengths of time en route to winter range. Cow 10 used an area in old-growth timber from 1-21 November. Cow 1 occupied an area with old-growth timber and large clearcuts from 20 October through 19 November. The bull used two separate holding areas; one from 28 October through 13 November, and the other from 14 November through 3 January. The first area was a mixture of seral brushfield and immature timber and the other was a mosaic of clearcuts and old-growth timber closer to winter range.

In November and December 1975 elk on either fall holding areas or summer range made greatest use of south and west exposures and gradually descended to lower elevations. These use patterns were probably responses to increasing snow depth and lower temperatures.

Fall Migration. Despite the similar migratory restlessness exhibited by most of the collared elk in response to the October 1975 snowstorm, the eventual completion of fall migration by individuals was highly variable. This was true even for elk that: used summer activity areas which overlapped, migrated along the same routes, and used the same winter range.

The period of migration for the 5 cows that migrated directly from summer to winter range varied from 12 to 28 days. The 2 cows and bull using fall holding areas took from 37 to 90 days to complete their migration. The bull (2) that exhibited erratic, long-distance movements outside his summer activity area from early October through early December, completed his migration in 51 days.

All elk probably were forced to complete their migration onto winter range by mid-December because of the 142 cm of snow that fell at Elk City between 21 November and 18 December. Four cows were on winter range by 6 December. Radio contact was lost with 2 of these cows before it could be determined whether they had definitely completed their migration. Three cows and 1 bull completed their migration by 18 December. One bull (8) used a fall holding area into January and did not complete migration onto a winter activity area until 26 January.

Movements between seasonal ranges were correlated with snow conditions and varied from year to year. In 1976, the 4 cows that were still being tracked completed their fall migrations about 30 to 50 days later than in 1975. Cow 10 completed her migration by 6 January and cows 4, 6 and 7 completed theirs by 5 January. These dates were 30, 50, 37 and 37 days later than the 1975 completion dates for each elk, respectively. The differences in snow conditions between the two fall-winter periods probably induced the later migration in 1976-77. In 1975, 229 cm of snow fell at Elk City prior to 1 January 1976. Only 30 cm of snow fell during the same period in 1976. A snowstorm that added a significant amount of snow between 12 and 16 January 1977 probably caused the 4 cows to complete their migration by 25 January. Following this storm, snow depth increased to 61 cm at Elk City and greater yet on the study area. Several investigators (Leege and Hickey

1977, Beall 1974, Telfer and Kelsall 1971, and Gaffney 1941) have reported that snow depths greater than 46 cm can restrict elk activities. Deep snow apparently serves as an incentive for elk to seek more favorable areas.

Migration Routes. In 1975, four of six collared elk (1, 7, 8 and 12) that summered in Newsome Creek migrated out of the drainage by going through the low divide along the ridge extending from Hamby Saddle to Baldy Mountain, near the vicinity of Lytle cow camp (**Figs. 3 and 4**). Cow 7 used the same migration corridor in 1976. The other 3 elk were not tracked in the fall of 1976.

Cows 6 and 10 appeared to have migrated out of Newsome Creek in 1975 somewhere between Pilot Rock and Baldy Mountain in the vicinity of Revelation Mine. Cow 10 used the same migration corridor in 1976, whereas cow 6 shifted to the corridor used by elk 1, 7, 8 and 12. Cow 6 wintered on the same area as these 4 elk in 1975-76, 1976-77 and 1977-78. Therefore, we suspect that the route traveled by cow 6 in 1976 was her traditional fall and spring migration corridor. Her aberrant fall migration pattern in 1975 was not repeated during the rest of the study.

The 2 cows that summered in Leggett Creek migrated out of the drainage near Reed Mountain. Cow 4 used the same fall migration corridor in 1975 and 1976. Cow 11 was tracked only during the fall of 1975.

A migration route for bull 2 was not discernible because of his erratic fall movements.

Distances traveled between summer and winter areas in 1975 ranged from 6 to 33 km and averaged 13 km. Seven elk made progressive movements along a narrow, direct migration corridor to winter range. The bull and cow (2 and 6) that migrated the longest distances traveled erratic routes to their winter ranges. Cow 6 traveled a much shorter route to her winter range in 1976.

Winter Activity

Five of six collared elk that summered in Newsome Creek migrated to seral brushfield winter range in the Clear Creek drainage (**Figs. 3 and 5**). The other elk (cow 10) migrated into the Meadow Creek drainage on the South Fork of the Clearwater River and wintered in a mosaic of old-growth timber and large clearcuts. The 2 cows that summered in Leggett Creek, wintered along the breaks of the South Fork of the Clearwater River. One of the cows wintered on a seral brushfield range near the mouth of Silver Creek. The other cow wintered on a bunchgrass range in the lower part of the Cougar Creek drainage. Bull 2 summered and wintered in O'Hara Creek drainage. His winter range was within the boundary of his summer range. The bull wintered on a small brushfield-bunchgrass area on steep, rocky breaks along O'Hara Creek.

Fidelity. Cows showed as much fidelity to winter range areas as they did to summer areas. Cow 6 was located on the same winter activity area during three consecutive years. Cows 4, 7 and 10 wintered on the same ranges both years they were tracked. Cows 4 and 10 wintered at a higher elevation in 1977 than in 1976, but their ranges for the two winters did overlap. During a winter aerial census in March 1978, cows 1 and 12 were observed on the same range as during the only winter they were radio tracked in 1975-76. Annual fidelity to winter range for 2 bulls and 1 other cow (11) was not ascertained because they were radio-tracked only one winter season.

Use Period. Elk occupied winter range from as early as 14 November to as late as 8 June during the first year of study. The length of stay on winter areas in 1975-76 ranged from 153 to 187 days.

The 4 cows that were still being tracked during the winter of 1976-77 arrived on winter range between 6 and 27 January — an average of 39 days later than in 1975-76. Only 3 cows were tracked through winter. All 3 were located on summer range on 31 May. They averaged about 125 days on winter range, 20 to 40 days less than in 1975-76. Considerably less snowfall during the winter of 1976-77 than during the previous winter (**Table 4**) allowed elk to minimize their stay on winter range.

Use Pattern. Elevations on winter range were considerably lower than on summer range. Elk wintered at elevations ranging from 762 to 1,524 m in 1975-76 and 914 to 1,829 m in 1976-77. Two cow elk wintered at higher elevations in 1976-77 than they did the previous winter. The other 2 cows still being tracked in 1976-77 wintered at about the same elevations both winters.

Land types on which elk were found most frequently through winter were dry and xeric breaklands with steep slope gradients.

The 78 radio locations of elk on winter range indicated that winter activity areas were considerably smaller than summer activity areas, ranging in size from 60 to 250 ha.

Spring Activity

Spring migration was fairly synchronous for 4 of the 7 elk tracked through the winter of 1975-76. All four, 2 cows and 2 bulls, left the winter range between 15 and 20 May. Cow 4 migrated sometime between 24 April and 14 May. Cow 10 did not initiate spring migration until early June. Cow 12 migrated to summer range between 21 May and 23 June.

The 3 cows (4, 6 and 7) still being tracked in the spring of 1977 were all located on their summer activity areas by 31 May. We surmise they migrated at about

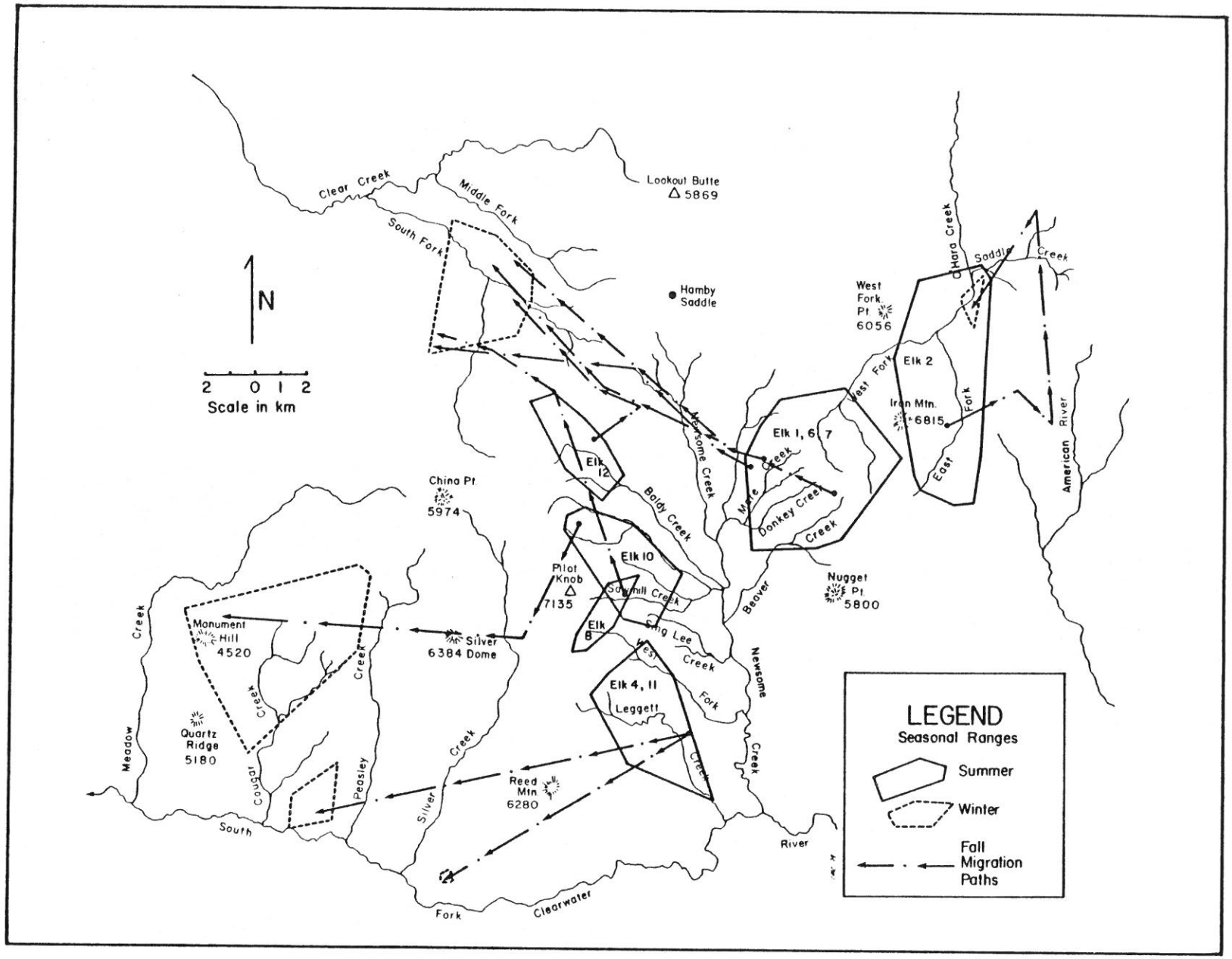
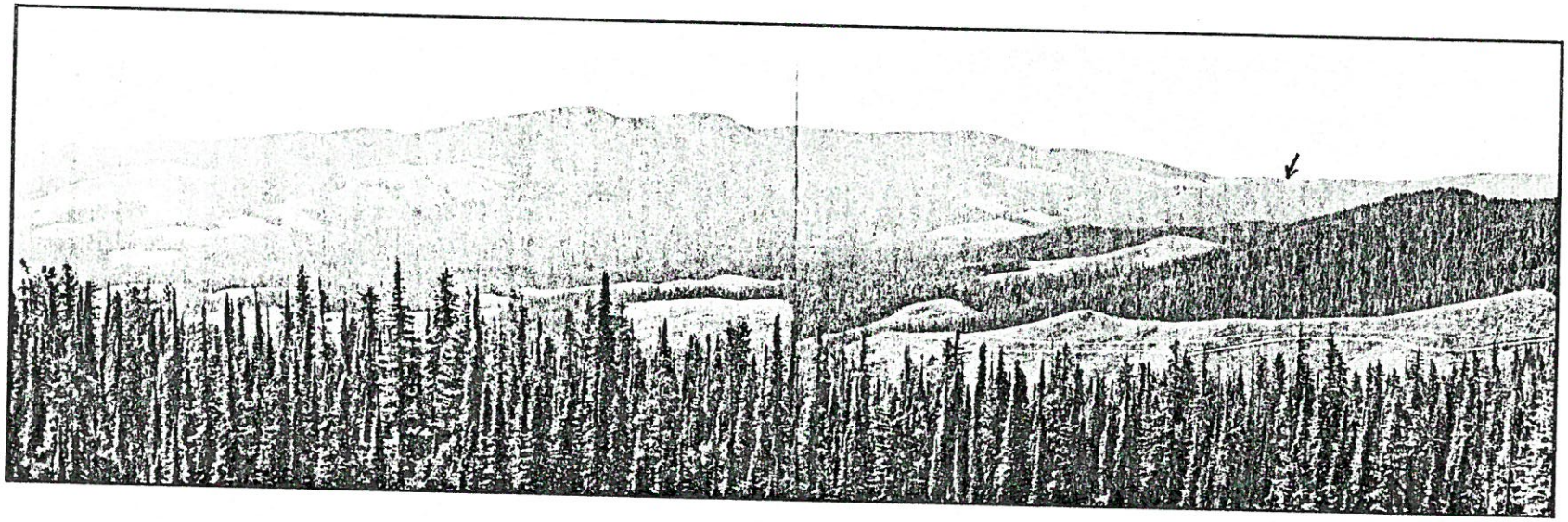


Figure 3. Migration routes from summer to winter ranges for 9 radio-collared elk.

Figure 4. Looking west across the Newsome Creek drainage from Elk Summit Lookout toward Pilot Knob. The arrow points toward Lytle Cow Camp, a major migration crossing.



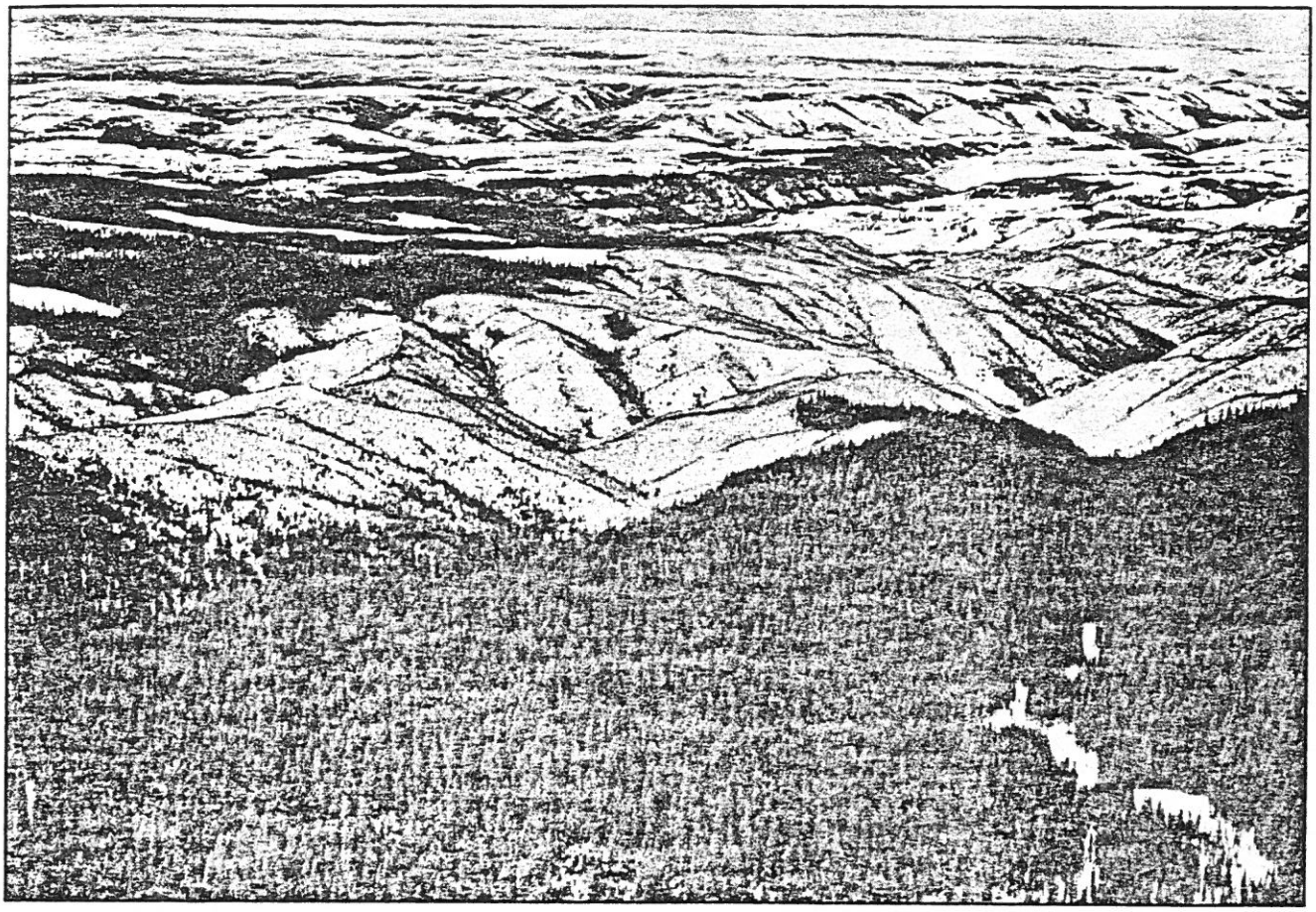


Figure 5. Looking northwest at the elk winter range created by wildfire in 1935 in the Clear Creek drainage.

the same time as in 1976 because snow conditions in April were similar both years.

On 17 April 1978 the 2 elk that still had functional transmitters were located along their spring migration routes. Prior to this date, no collared elk were known to have dispersed from winter range before early May. Cow 6 was near her summer activity range with her spring migration about 95% complete. Cow 4 was located in the Silver Creek drainage about midway along her migration route.

Spring migration periods showed considerable annual variation. Most of the variation appears to result from the timing of snow melt and subsequent phenological differences in available forage. McLean (1972) suggested that a combination of environmental and behavioral factors influenced the timing of spring migrations of elk in the Lochsa River drainage in Idaho. He indicated that temperature showed the closest relationship to elk movements in spring, but plant development and calving also influenced spring movements. Other investigators (Dalke et al. 1965, Murie 1956, and Brazda 1953) also reported that plant phenology and calving influence spring elk movements and migrations.

Migration Traits of Cows. Spring migration for all cows was a reverse movement over approximately the same route traveled during fall migration. It was more abrupt, direct and of shorter duration than fall migration. In early May 1976, 2 cows moved directly from winter range onto the areas they occupied the previous summer in less than 7 days. The quickest fall migration for a cow was 12 days.

An instinctive urge to calve on summer range might trigger the sudden and rapid spring movements by cows. Migration was completed prior to calving by 3 cows monitored through the spring of 1976 and 1977. Two cows calved on their traditional summer activity areas, while the other cow calved on a spring "holding area" at a lower elevation and immediately adjacent (2 km ESE) to her summer activity area. She used the holding area all three years she was monitored and for about three weeks each time before moving onto her summer area in early June.

Cow 10 was the only cow that did not migrate to summer range in Newsome Creek prior to calving in 1976. During May and June, she lingered on winter range and spring holding area adjacent to (3.2 km E) and at a slightly higher elevation than her winter range.

The holding area also served as a portion of her winter range in 1976-77 and had a good distribution of old-growth timber and large clearcuts. The cow used this area until 23 June. On 25 June, she was located on the area occupied the previous summer in Newsome Creek 11.1 km ENE of her last location on the spring holding area.

Migration Traits of Bulls. Spring migration for the 2 bulls was characterized by highly erratic and rapid movements over long distances. In the spring of 1976, both bulls migrated to the areas they occupied the previous summer in Newsome and O'Hara Creek drainages, but neither stayed.

Bull 8 migrated from winter range to his 1975 summer activity area on two separate occasions, once on 21 May and again on 9 June. Each time, after staying only two weeks, the bull returned to areas on the Clear Creek winter range that he had occupied the previous fall and winter. He was still using the Clear Creek area when we lost contact with him on 6 August 1976.

Bull 2 traveled a distance of 40 km in 40 days in the spring of 1976. He traveled towards, then away from, and finally back onto his 1975 summer activity area. He moved south from his winter range along O'Hara Creek to a site 1.6 km W of Iron Mountain and the nearest boundary of his 1975 summer activity area (**Fig. 3**). From there, he moved south to a ridge 1.6 km N of the South Fork Mine along the South Fork of the Clearwater River. He was located even farther from his summer activity range when he was found in Maurice Creek in early June. From Maurice Creek, bull 2 started back towards his summer activity range. He was located 0.8 km ENE of Elk Summit on 9 June. By 23 June he was 9.6 km N of this location on his 1975 summer activity area. He stayed on this area for only two weeks. On 5 July he was located 4.6 km N of his summer range, on an area he had used for 6 days in October 1975. This area eventually became a part of his greatly expanded summer activity range for 1976.

Habitat Use and Selection on Summer Range

We have already described seasonal elk distributions, movements, activity patterns and activity range areas. In this section we evaluate the relationships between elk use and various biological and physical habitat factors.

Both topographic and vegetational attributes of elk habitat were analyzed for each radio location. Topographic variables investigated were elevation, aspect, slope and land type; vegetational attributes included habitat and cover types and cover:forage ratios. Habitat components were examined only as single independent variables with respect to elk utilization.

Habitat use and selection were analyzed on two levels of resolution. The first level analyzed the combined locations of all radio-collared elk in relation to habitat variables within the entire study area. However, use patterns for elk as a group were not statistically compared to habitat availability. Spring, summer and fall seasons were defined as calendar months May-June, July-September and October-November, respectively. In the second level of analysis, we analyzed individual elk locations with respect to the availability of habitat components within each individual's summer activity area.

Analyses were done for the total summer activity area occupied by an individual from May through December during one or two consecutive years. Analyses by weekly, monthly or seasonal periods were not attempted because sample sizes for individuals for such short time periods were too small to show statistical significance. However, smaller time periods probably reflect changes in elk needs and activities more accurately.

Analysis of utilization-availability data involved the calculation of a selectivity index for the habitat variables for each elk. Selective use was ascertained by Chi-square and Bonferroni z test statistics (Neu et al. 1974) between observed and expected elk use of habitat variables. Selectivity was considered significant at the $P < .10$ level. Selection or preference for a particular habitat component indicated that use was greater than availability at the 90% confidence level. Selection against or avoidance meant that use was less than availability at the same confidence level. The hypothesis tested was that individual animals utilized their habitat selectively.

Habitat Types. Habitat types on summer range that were used by radio-collared elk are listed in Appendix A. Elk were found most frequently in grand fir and cedar *(Thuja plicata)*/queencup habitat types from spring through fall. A rich mixture of moist site herbs and scattered shrubs accompanied queencup in the understory. Peak use of these habitat types occurred in spring, early summer and through fall. Use declined slightly in mid and late summer when some elk use shifted to subalpine fir types.

The grand fir and cedar/queencup types constituted over 50% of the habitat in 8 of the 10 activity ranges, and 15% and 42% in the other two ranges. In 8 of the activity areas, grand fir was the dominant tree species, and only small numbers of cedar were part of the climax overstory. Fir and cedar were co-dominants in the other 2 activity areas.

Elk did not use habitat types in their activity areas selectively. Six elk spent over 50% of their time in the fir-cedar type. Though all but 2 elk were found in this type most often, they only used it in proportion to its availability. It was difficult for elk to be selective within their activity range since habitat composition was relatively homogeneous and few choices were available.

Cover Types. The habitat type classification system, based on potential climax vegetation, is an ecologically sound way to classify forest plant communities and is a useful tool to forest managers. However, several successional stages of cover types may occur within any habitat type. Because elk respond to cover types (existing vegetation) the habitat type for an area has little value by itself for predicting elk use. For example, Irwin (1978) observed significant differences in elk use among different seral stages of the same habitat type. Consequently, an awareness of the variation in cover types within and between habitat types is necessary.

Cover types occurring on our study area are listed in Appendix B. Dense (>70% crown coverage) timber types received the greatest elk use in all seasons.

In spring, elk use was greatest and about equal in dense old-growth, small sawtimber, and pole stands. Clearcuts were the second most used cover type at this season.

Elk were found most frequently in old-growth timber throughout summer. This cover type was characterized by large (dbh >76 cm) over-mature grand fir trees with dense canopies and interspersed with numerous natural micro-openings supporting abundant and diverse forage plants. Clearcuts continued to receive as much use as the next most used cover type (two-storied stand with dense understory) through early summer. There was a decline in use of openings in late summer (**Table 2**). Herman (1978) found elk use concentrated in clearcuts in July. He noted that forage use in clearcuts remained high through August, but utilization of timbered areas increased considerably over that observed in July.

Elk use of dense old-growth timber peaked in October and continued to receive greater use than other cover types through fall. Use of clearcuts was least in October, but a dramatic increase in use occurred in November in response to the first major snowstorm of the season between 22-28 October. In November, elk used clearcuts as often as dense, immature timber and two-storied stands. Elk that were still on summer range in December were most often located in or adjacent to clearcuts.

Physical, biological and social factors that might have contributed to the daily and seasonal use patterns of elk were discussed by Hershey and Leege (1976).

Individual Elk showed more selection for cover types than habitat types on summer activity areas. Four elk appeared to be relatively selective in use of cover types, while 5 others were non-selective. Variability of cover types within individual ranges also was greater than for habitat types.

Two cows and 1 bull displayed a preference for the dense old-growth type. Both cows spent over 70% of their time there. However, both maintained activity ranges which had over 50% in the dense old-growth type. Another cow's entire range was in dense old-growth forest. This cover type was the only type found in the ranges of all the elk. Less dense old-growth timber types were available in the ranges of 6 elk in small amounts. Use of these more open stands was proportional to their occurrence. Hancock's (1976) results indicated that elk residing in the upper reaches of Newsome Creek showed a slight preference for old-growth timber.

The selection of dense, small sawtimber and pole types was as variable as their availability within individual ranges. Elk displayed preference, avoidance and proportional use for these timber types. Less dense, small sawtimber and pole stands received proportional use.

The two-storied stand was the only cover type for which elk showed a common use pattern. Seven elk displayed a trend toward disproportionately less use of two-story timber types than was available within their ranges.

Clearcuts at various seral stages occurred in the activity areas of 6 cow elk. Clearcuts comprised less than 20% of the summer activity area of all cows but one. The clearcut area in this cow's range was 26%. She (7) was the only elk that showed significantly less than expected use of clearcuts. All other cows used clearcuts proportionately. Since our observations were made during daylight hours, they do not reflect higher levels of use that elk probably made of clearcuts after dark.

Observations of unmarked elk on the study area in 1974 revealed that clearcut age classes 1-13 were used in proportion to their availability within the study area. About 50% of the elk observations in clearcuts were in the 1-6 year old age class, which constituted approximately 67% of the clearcut acreage in the study area.

Elk used clearcuts of all sizes in proportion to their availability. Clearcuts smaller than 41 ha comprised 24% of the cutover acreage in the study area and accounted for 26% of all elk observations in clearcuts in 1974. Larger clearcuts constituted approximately 75% of the clearcut acreage and an equal percentage of elk observations. Lyon (1976) found that elk use diminished substantially when clearcut size exceeded 40 ha.

Elk seldom traveled farther than 92 m from the edge of a clearcut during daylight hours. Sixty-six percent and 92% of all elk groups (N = 93) observed in clearcuts from spring thru fall were within 92 and 183 m, respectively, of a timbered edge. Reynolds (1962 and 1966) found that elk use of logged areas decreased at distances beyond 183 m from the edge of cover.

Elk traveled farther into clearcuts in early spring and late fall than in summer. Factors that may account for this were discussed by Hershey and Leege (1976).

Unmarked elk selected for clearcuts treated for slash removal and avoided untreated units. Lyon (1976) showed that elk use diminished when slash inside cutting units exceeded 0.5 m in depth. Approximately 70% of the cutover acreage in the study area was treated for slash removal. Clearcuts treated by

broadcast burning were preferred, while elk use of dozer piled — burned clearcuts was proportional to availability.

Cover/Forage Ratios. Optimum elk habitat has been described as the aggregate and arrangement of cover and forage areas that results in the greatest possible use of the greatest area by elk (Black et al. 1976). Therefore, vegetation changes caused by timber management activities will affect elk habitat since each successional stage provides forage and/or cover.

Recently, a procedure was developed to quantitatively evaluate the effects of alternative timber management activities on elk habitat in the Blue Mountains of Oregon and Washington (Black et al. 1976). The ratio of cover to forage areas and their size and arrangement in time and space was the tool used to predict elk response to habitat alteration.

In 1977, this method was modified and expanded to evaluate the quality of elk habitat in northern Idaho (USDA et al. 1977). These guidelines are currently being updated by elk workers in northern Idaho. Current information indicates that optimum cover: forage ratios range from 75:25 to 50:50.

We ascertained existing cover/forage ratios for 8 summer activity ranges to compare with the optimum ratios just mentioned. The cover/forage ratio for the study area was also calculated for comparison with ratios for individual activity areas to determine if elk used the study area selectively with respect to forage and cover. In our calculations we assumed all forested sites (regardless of percent crown cover) were cover, and all natural and man-made openings were forage areas.

Cover on all activity areas exceeded 50% (range 67-95%). Six of the 8 activity ranges had cover values that exceeded 75%. The cover/forage ratio for the entire study area was 75/25.

Four elk preferred to use areas of almost continuous forest and avoided openings. No man-made or natural openings larger than 6 ha were present within the ranges of three of these elk. Four other elk used activity areas with forested and open areas in proportion to their availability within the study area. No elk activity ranges had more than 35% in openings.

The high proportion of cover to forage in the elk activity ranges and the study area was somewhat deceiving. In actuality, old-growth forest stands which we classed as cover had numerous small openings resulting from past insect epidemics and/or high water tables. These old-growth forest stands with micro-openings provided elk with needed cover and forage areas.

Land Types. The land type (USDA 1978) is an ecological classification of the landscape that is based upon similarities in physiography, land-forming processes and climax vegetation. The classification integrates several sciences and is used in national forest land use planning. Since no research has yet related elk habitat use and selection to this relatively recent concept, we analyzed our data to determine if elk displayed selectivity for land types.

Forty-seven land types were identified in 10 summer activity ranges. Seven additional land types were delineated on winter range. The types were grouped into nine general categories (Appendix C) to accommodate statistical analysis.

Elk were found most frequently on land types characterized as cool, moist and poorly drained from spring through fall (especially types 32-4F and 32-5F). Use of this group gradually increased from spring through summer, and peaked in early fall (October). A decline in use occurred in November when elk shifted to drier types. Dry-xeric and cool-moist, but well drained types were used most often in late fall and spring and least in October.

The most frequently used and most available group of land types within the activity ranges of all but 1 elk were the cool, moist, poorly-drained areas. Seven elk were located in these types over 50% of the time. However, all these elk maintained activity ranges which had greater than 50% of their areas within land types in this group. All other land types were used in proportion to their availability with few exceptions.

Elevation. Elevation on summer range varied from 1,158 to 2,173 m and was categorized into 152 m intervals.

In early spring (May), elk on summer range were found most often from 1,219 to 1,524 m because of residual snow cover and limited available forage at higher elevations. Elk followed the receding snowline during spring and were located most frequently between 1,372 and 1,676 m in June.

Throughout summer and into early fall, elk use was greatest at elevations of 1,524 to 1,676 m. Elk shifted to lower elevations in response to snow accumulation. By mid-fall most elk use was distributed between elevations ranging from 1,372 to 1,676 m.

Slope. Elk were found most frequently on terrain of less than 20% slope in spring. In early summer (July), elk use on areas that varied from flat to slopes of 60% was about the same. Elk use was greatest on slopes of 20% to 40% for the remainder of summer and through fall. Use in late fall increased on areas with less than 20% slope. Slopes steeper than 60% received the least use during the period elk were on summer range.

Although 6 elk did not use slope selectively, gradients less than 20% were used disproportionately greater than expected by all elk. Areas of such gentle topography were of limited availability, comprising less than 25% of the area within all but one activity range. Hancock (1976) also found that elk in the upper reaches of Newsome Creek showed a preference for flat topography. This preference was reflected in the numerous trails and

bedding sites he observed on spur ridges.

Elk used areas of 20% to 60% slope in proportion to availability. Topography this steep was the most common in all activity ranges. Elk showed a trend toward avoidance of terrain over 60% gradient. Use of slope was more consistent among individual elk than use of any other habitat feature.

Aspect. Exposure was measured in 90° increments, providing four possible categories: North, South, East and West. The gently undulating terrain in Newsome and Leggett Creek drainages was characterized by numerous broad, flat ridges, benches and stream bottoms and necessitated a fifth aspect category — level.

In spring, elk use was greatest on level terrain. Elk continued to make high use of flat topography through mid-summer, but showed a trend toward greater use of north and east exposures through summer and into early fall. Although elk were found most frequently on relatively level areas again in November, locations indicated an apparent shift to aspects facing south and west.

Because individual summer activity ranges occurred in areas that differed substantially in overall exposure, considerable variation in use and selection of aspect was observed among individuals. The greatest variation was evident for aspects facing north and west. No recognizable use patterns emerged for these exposures. East exposures were used in proportion to their availability in all activity ranges. Seven elk showed a tendency to select against aspects facing south. All but 1 elk exhibited a trend toward disproportionately greater use of level terrain. Three elk showed significant preference for level topography.

Selectivity Patterns. Our findings indicated that while individual animals showed selection for certain habitat features, there were few consistent patterns of selectivity among the animals monitored. Apparently, habitat selection was most related to availability of habitat components within activity areas. Animals that occupied areas of essentially similar environment had similar selectivity patterns, while dissimilar patterns of selection were evident for animals that occupied areas of dissimilar character.

However, habitat selection occasionally was confounded by animal behavior. In one instance, successional stands of dense pole and small sawtimber occurred in 3 elk activity areas in the same proportion (25% of the area). One elk selected for, another against, and the third used the timber type in proportion to its availability. Also, certain elk were more selective than others. The 2 youngest elk, a bull and cow, with the largest summer activity areas showed greater selectivity for habitat components than all other elk. Both elk used several components in five of six habitat categories in a selective manner. Two older elk, a bull and cow, with much smaller ranges used only one component in six habitat categories selectively.

Elk Response to Hunting in Relation to Logging and Access

Hunting Seasons and Regulations. From at least 1952 through 1974, hunters were allowed to harvest 1 elk of either-sex in the Newsome-Leggett Creek area during a 30 or 31 day season that opened either the last Saturday in September or the first Saturday in October. In 1975, the season was shortened and split between either-sex (1-12 October) and bulls-only (13-26 October). Opening day also was changed from the traditional Saturday to Wednesday. Since 1975, there has been a 26-day bulls-only season. Opening day is the Wednesday closest to 1 October.

The Newsome-Leggett Creek area also has had an elk archery season since 1972. Prior to 1976, it was a 30-day, either-sex season that opened the last Saturday in August or first Saturday in September. In 1976, season length was reduced to 23 days and a bulls-only harvest was specified. The season remained the same through 1977, but in 1978 archers were again allowed to kill either-sex. Newsome and Leggett Creeks also were open for a late season archery hunt in December from 1972 through 1975.

Elk Harvest. The earliest elk harvest data for Newsome and Leggett Creek drainages are the 1959 hunter report card returns. Data since 1959 indicate there was a sharp decline in the Newsome-Leggett elk harvest between 1960 and 1965. Since 1965, annual fluctuations in the harvest indicate that the population has stabilized, but at a lower level than was present in the 1950's. The archery elk harvest in the drainage has been light relative to the general season harvest.

Harvest Trent in Relation to Logging and Access. Leege (1976) showed a negative correlation between winter elk counts and logging activity on summer and fall range in the Pete King Creek drainage of north-central Idaho. To ascertain whether such a relationship might help explain the sharp decline in the Newsome-Leggett elk harvest between 1960 and 1965, we compared the harvest trend with the annual increment in logged areas on the study area each year. No correlation was evident between the trends in elk harvest and logging activity. However, less than 2% of the study area was logged during the period of declining elk harvest compared to over 50% of the summer range logged in the Pete King study.

Thiessen (1976) postulated that a substantial reduction of elk in Game Management Unit 39 in west-central Idaho between 1960 and 1974 was caused by direct over-harvest of females. He indicated this occurred because of hunting seasons promoting high level hunting opportunities and proliferating access into

unroaded elk habitat to facilitate timber harvest. In order to evaluate the effects that additional access had on elk harvest in the Newsome-Leggett area, we compared harvest trend with the annual increment in total road miles within the study area.

The relationship between access and harvest prior to 1959 was unknown. Almost 50% of the total road mileage within the study area was completed prior to 1959, the first year for which elk harvest data were available. This access was for mining and fire control; none of it was related to logging. A correlation between the trends in harvest and road mileage since 1959 is not evident.

Harvest Distribution in Relation to Logging and Roads. Field checks and hunter questionnaires indicated that hunters killed at least 50 elk on the study area in 1975. Thirty-four percent of the elk were killed in clearcuts that constituted only 17% of the total acreage of the area. Thirty-eight percent were killed within 400 m, and 88% within 800 m of a road. Only 12% of the harvest was farther than 800 m from a road. Elk using areas within 800 m of a road were more likely to be harvested than those further away.

Influence of Road Closures on Distribution of Hunters and Harvest. One week before the 1975 season opened, several roads on the study area were closed to all motorized vehicle access under an agreement between the U.S. Forest Service and Idaho Department of Fish and Game. The road closures had a definite influence on hunter distribution.

Three areas that received considerably less hunting pressure in 1975 than 1974 because of the road closures were the Donkey-Mare Creek, Sing Lee-Sawmill-West Fork Creek, and Radcliff Ridge areas. Areas where roads remained open undoubtedly absorbed much of the pressure normally received in these now inaccessible areas.

We surmise that the change in hunter distribution caused a corresponding change in the distribution of harvest. Elk that used areas which were still accessible probably were more vulnerable to harvest than elk using inaccessible areas.

On a questionnaire we asked hunters about their opinion on roads in regard to elk hunting on the study area. Of 47 respondents, 47% indicated there were already too many roads, no new roads should be constructed, and some existing roads should be closed. Thirty-four percent felt that present access was adequate for hunting and any new roads constructed for logging should be closed to public use. Only 9% of those responding indicated that additional roads should be constructed in the future to improve access for easier hunting. The remaining 10% had no opinion. These results are very similar to those obtained with a survey conducted by the University of Idaho in 1971 when about 4,600 Idaho residents gave their opinions about roads and big game hunting (Bjornn and Dalke 1975).

Elk Response to Hunting Activity. Three cows and 2 bulls exhibited irregular movements outside the perimeters of their summer activity areas in what may have been responses to hunter encounters during the first week of the general elk season in October 1975. Hunting pressure was heavy during the first 12 days of the season, 1-12 October. All 3 cows moved back onto their activity areas before hunting season ended on 2o October. The 2 bulls did not return to their summer areas in 1975.

Sometime during opening morning of the season, cow 12 moved 2.0 km NNW of her location the previous morning. A bull and calf elk were shot within the immediate area of the later location during early morning on opening day. She remained in this new area for at least 11 days before returning to her summer activity area between 10 and 14 October. On 17 October cow 12 was located within 600 m of the area where the bull and calf were shot. She did not move outside her activity area during the remainder of the season. Cow 12 exhibited similar long distance movements off her activity area during the elk archery season in September. We suspect these movements were a response to hunter contacts also.

Cow 1 was located 1.2 km NNW of the nearest boundary of her summer activity area on the third morning of the season, 3 October. It was the first time she was found outside her activity area since her capture 4 months earlier. On the next flight, 8 October, she was located 3.2 km SSE of her previous location and 800 m SSE of the nearest boundary of her range. She was back on her activity area the next day and within 300 m of the last location in her range on 2 October. She showed a similar response to apparent hunter disturbance later in the season.

On the second afternoon of the hunting season, cow 7 was located 2.8 km SSE of her location on opening day and 600 m south of the nearest boundary of her summer activity area. The area she occupied on opening day received heavy hunting pressure. Like cow 1, this was the first time cow 7 was found outside her activity area since her capture 4 months earlier. On the next flight, 8 October, cow 7 was located back on her activity area only 100 m away from her location on opening day. She stayed in her activity range for the rest of the season.

A fourth cow (6) moved 400 m south of her nearest activity range boundary for a few days during the third week of the season. Although hunting pressure was light at the time, she might have moved in response to hunter disturbance.

Bulls 2 and 8 exhibited highly erratic, long distance movements outside their summer activity areas during the first three weeks of hunting season. Both bulls moved off their activity areas during the first week.

Their first locations outside their activity ranges were 2.0 and 2.6 km, for bulls 2 and 8, respectively, from their nearest range boundaries. Neither bull returned to his summer activity area in 1975.

Gruell and Roby (1976) and Irwin and Peek (1979) also found that fall movements of radio-collared elk were strongly influenced by hunters. They indicated rutting behavior may have a significant influence on movements during this period, too. We believe the rut had little influence on the irregular movements we observed in October because the rut begins in early September prior to opening of the general hunting season. Movements off summer activity areas were not observed at that time.

During the general elk hunting season in Montana, Lemke (1975) also noted that several of his radio-collared elk made long-distance moves off their summer ranges which greatly exceeded their normal activity patterns. He reported, as we have, that hunting activity was only a temporary disturbance and many of his collared elk soon returned to their pre-season activity areas.

Elk Response to Active Logging

Upper Beaver Creek Sale. We monitored the reactions of 2 collared cow elk (1 and 6) to a low intensity logging operation. Upper Beaver Creek Sale was located 1.6 km S of the nearest elk summer activity area boundaries from 20 August through 17 December 1975 (**Fig. 6**). The sale involved the removal of timber from seven cutting units ranging from 3 to 24 ha in size. One unit was clearcut, overstories were removed on three units and everything but seed trees were cut on the other three units. Road construction for the sale was completed prior to initiation of our study. Activity on four units occurred during August through October when it might have had a significant influence on the movements of elk 1 and 6. A descriptive narrative of the response of these 2 cows towards the disturbance follows:

Logging was conducted on a 19 ha seed tree unit (2) from 20 August through 9 September 1975. The logging was approximately 1.6 and 2.2 km from the geometric centers of activity (Hayne 1949) of elk 1 and 6, respectively (**Fig. 6**). Neither elk exhibited movements that indicated an avoidance response to the disturbance. From 15 September through 17 December timber was harvested on a 19 ha seed tree unit (3) and a 9 ha clearcut (4). About 1.5 km separated logging in unit 4 from the activity centers for cows 1 and 6. Neither showed avoidance reactions to the disturbance even though this operation was the closest to their activity centers during the sale. Tree harvesting occurred on a 16 ha seed tree unit (5) in October 1.4 km SSE of unit 4. We detected no movements away from this disturbance by either of the cows.

Cow 1 used a summer area closest to the sale area. The center of activity for radio fixes (N = 27) obtained for this elk during logging was located only 400 m NNE of the activity center for all her radio fixes (N = 15) obtained prior to logging (**Fig. 6**). For elk 6, the activity center for fixes (N = 15) obtained during logging was only 400 m WSW of the activity center for her fixes (N = 15) obtained prior to logging. These short distance shifts in the location of activity centers during logging indicated that neither elk moved away from the disturbance.

Noises associated with the timber harvest operations were audible to both cows from late August through October. However, no activity associated with the sale actually occurred within the activity areas of the elk. Logs were hauled over roads going away from the summer activity areas of both cows. Spur ridges, two forks of Beaver Creek and old-growth timber intervened between most radio locations for the cows and the logging disturbance.

The location of elk kills during the 1975 general elk hunting season indicated that elk did not move far from the four cutting units. Seventeen, 8 and 4 elk were killed within a 1.6, 0.8 and 0.4 km radius, respectively, of the edge of these cutting units. No logging was done on any of the units during hunting seasons. Ward (1976) reported that some elk moved back to timber harvest seasons. Ward (1976) reported that some elk moved back to timber harvest areas within three weeks after logging activity ceased.

O'Hamby Sale. We had a second opportunity to observe the response of cow 6 to logging activity during the summer of 1976. A high intensity timber harvest operation, identified as the O'Hamby Sale, was conducted from July through November within the boundary of that part of her 1975 summer activity range that occurred in the West Fork of O'Hara Creek (**Figs. 2 and 6**). Timber was removed from two shelterwood units (8 and 9) that were 101 and 41 ha in size, respectively. Road construction for the sale was completed in October 1974 prior to initiation of our study.

Elk 6 showed a definite avoidance of the logging that occurred within her summer activity area in unit 8 in 1976. In August and September 1975, elk 6 occasionally used an area in the headwaters of the West Fork of O'Hara Creek adjacent to the major ridge separating the Newsome and O'Hara Creek drainages. The area was used frequently enough to be included as a significant part of her summer activity range for 1975 (**Fig. 6**). Elk 6 was located near the perimeter of unit 8 on six flights during the summer of 1975. Unit 8 was still uncut and there was no human activity on the unit at this time.

In early June 1976, cow 6 again was observed using the perimeter of unit 8 prior to logging. Logging was initiated on 12 July 1976. After this date, cow 6 was never located again in that part of her summer activity range in 1976 or 1977. She stayed in the Newsome

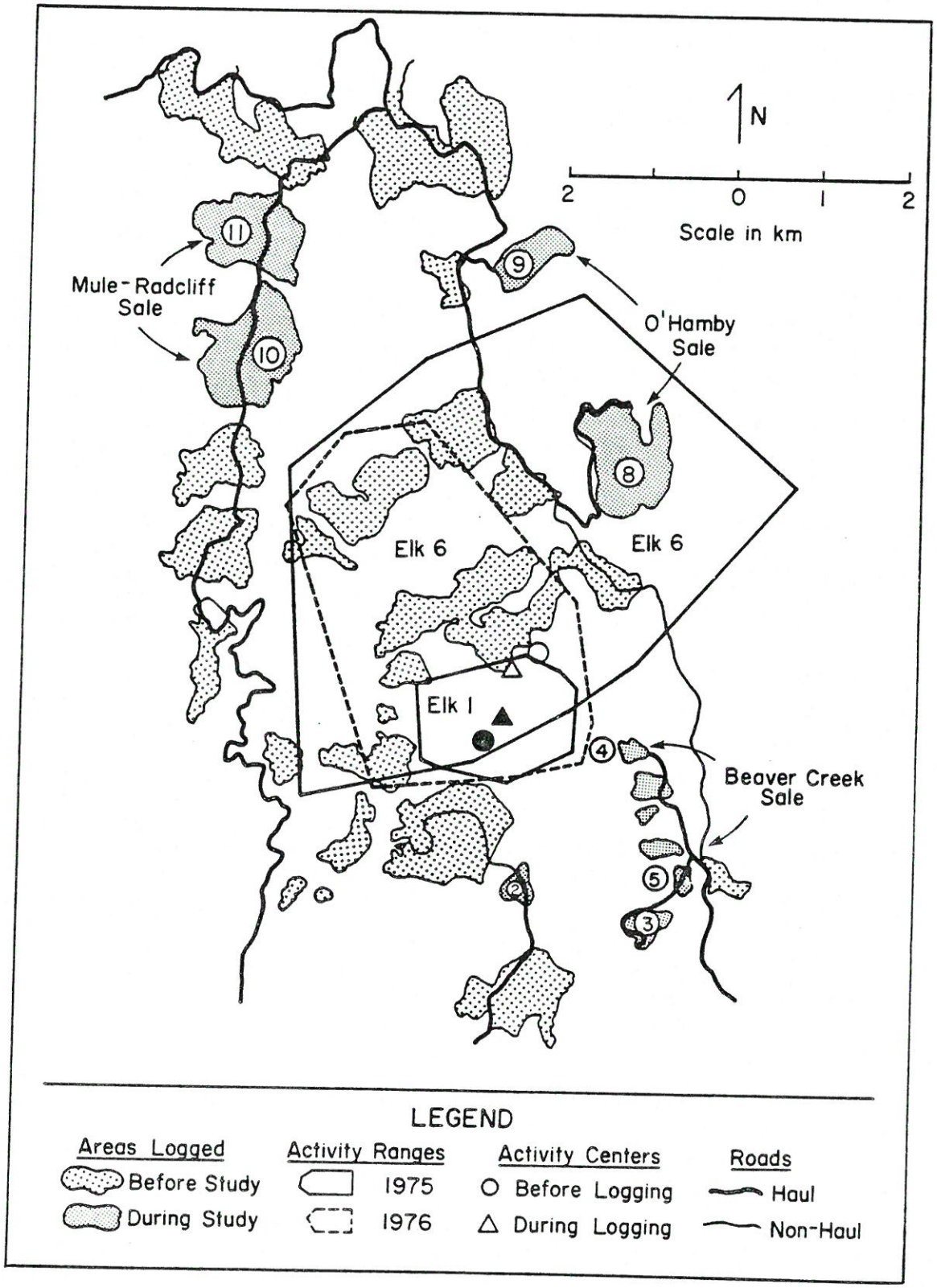


Figure 6. Changes in summer distribution of elk 1 and 6 as related to logging activities.

Creek drainage and was never located on or over the major ridge separating the two drainages. Logs from the sale were hauled over a main road located on this ridge. After 12 July cow 6 used only 45% of the summer activity area she occupied in 1975 (**Fig. 6**). Approximately 1.2 km was the closest cow 6 was located to unit 8 in 1976 after logging began.

Timber harvest activity on unit 9 started in October 1976 and appeared to have no effect on elk 6 since she was already avoiding that part of her summer range because of disturbance in unit 8. Cutting units 8 and 9 also abutted the perimeter of the 1975 summer activity area for cow 7 (**Fig. 2**). Cow 7 exhibited the same avoidance response as cow 6 to the activity in unit 8 in 1976, although it was less apparent. She used that part of her summer activity range in the West Fork of O'Hara Creek in June and July 1976 prior to and during the first two weeks of logging. Logging activity was still light at this time. Her last radio location in this part of her range was on 28 July. Thereafter, in 1976 and 1977 her summer activity was confined to the Newsome Creek drainage, beneath the major ridge separating the two drainages. The closest cow 7 was located to unit 8 after 28 July 1976 was approximately 1.6 km.

Mule-Radcliff Pulp Sale. Neither elk 6 nor 7 obviously avoided timber harvest operations that occurred on units 10 and 11 of the Mule-Radcliff Sale from 7 June through 9 December 1976. Both units were well outside the 1975-76 summer activity ranges for the two cows.

Lyon (1975) suggested that displacement of elk as a result of logging activity could be reduced if an inaccessible security area was available to elk immediately adjacent to the disturbed area. Adequate security was provided by undisturbed dense timber or a topographic barrier that broke straight line contact between the activity and the elk. We suspect that our collared elk were not displaced by logging disturbance associated with the Beaver and Mule-Radcliff sales because dense vegetation, topography and distance buffered them from the disturbance.

Elk displacement did occur when the high intensity O'Hamby Sale took place on, or abutting, areas actually used by elk. Under these circumstances, elk shifted to a more secure part of their activity area well removed and buffered from the disturbance by distance and topographic barriers. Ward (1976) also reported that intense timber harvest activity had an influence on elk distribution. He showed a large reduction in elk use within 800 m of logging activity.

Elk Response to Roads

Two elk summer activity ranges were completely devoid of roads, while six other ranges were crossed by main, secondary and/or primitive roads. Four elk that occupied areas with few or no roads used their ranges in a non-selective manner with respect to distance from roads. The 4 elk that occupied highly accessible ranges preferred areas further than 400 m from traveled roads and avoided areas within 200 m of roads. Areas between 200 m and 400 m from roads were used in proportion to their availability within the activity ranges of each individual.

For the non-radioed elk, selectivity of areas in relation to proximity to traveled roads was evaluated for the study area. Timber harvest and recreational activities generally peaked from August through October. During this three-month period, elk as a group (all observations) showed the same response to roads as the radioed elk. The mean distance elk were located from the nearest road was 800 m during this period. The mean distance to the nearest road from 200 random observations was 550 m.

Human activity was less on the study area during the remainder of time (June, July and November) that elk were on summer range, and elk locations in relation to traveled roads reflected this lowered activity level. During these months, elk made proportionate use of all areas irrespective of the proximity to a road, and no selection was evident. Elk were closer to roads in June and November (mean = 370 and 480 m, respectively) than at any other time. Snow accumulation in November, and residual snowfields and extremely wet and muddy road conditions in June, greatly restricted human activity. As road conditions improved through July, activity intensified, and elk were located farther from roads. Mean distance elk were found from the nearest road in July increased to 580 m; 30 m greater than the expected mean distance. Marcum (1975) also observed elk closer to roads during June, July and November than during other months, and farthest from roads in October.

RECOMMENDATIONS

1. Biological and physical habitat features which are important for elk during the hot summer months should be carefully evaluated before altering a site. Desirable habitat features include: stands of old-growth grand fir with numerous micro-openings at elevations from 1,524 to 1,676 m; benches, ridges, stream bottoms, and other terrain of less than 20% gradient; and poorly drained, cool moist land types.

2. Timber harvest operations should be restricted to the smallest area practicable and completed in the shortest possible time. Ideally, logging and road building should not be conducted on areas during periods when elk are present — particularly during calving and peak migration periods.

3. Adjacent undisturbed habitat should be available to elk dispersing from sale areas during logging and/or road building operations. Undisturbed areas should be about 1 km (3,280 ft) away from disturbance and

should be no smaller than the average summer activity range size of about 1,000 ha (2,471 acres).

4. Important components of elk habitat should be isolated from main and secondary roads by at least 100 m of dense vegetation to protect elk from harrassment. These components include: calving areas, wallows, mineral licks, and stream bottoms. Also, maintain cover screens between traveled roads and forest openings, including clearcuts and meadows, to increase their value as forage areas.

5. To ensure the greatest possible use of forage areas produced by logging, width of clearcuts should not exceed 275 m (900 ft) and slash produced by logging should be removed by broadcast burning.

6. Use road closures as a method of ensuring that elk use the best components of their habitat. Road closures during hunting seasons can be used to control hunter access, harvest distribution and extent, and the style and quality of hunting.

7. The Newsome Creek-Clear Creek divide should be treated as an important elk migration crossing, particularly at the lowest elevation near Lytle Cow Camp.

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APPENDIX A

Habitat types identified in the summer activity ranges of nine radio-collared elk. The habitat type classification system followed here is that of Pfister et. al. (1974).

Abies grandis/ Clintonia uniflora
Abies grandis/ Xerophyllum tenax
Abies lasiocarpa/ Clintonia uniflora
Abies lasiocarpa/ Vaccinium scoparium
Abies lasiocarpa/ Xerophyllum tenax
Abies lasiocarpa/ Menziesii ferruginea
Pseudotsuga menziesii/ Physocarpus malvaceus
Thuja plicata/ Clintonia uniflora
Thuja plicata/ Adiantum pedatum

APPENDIX B

Cover types identified in the summer activity ranges of nine radio-collared elk.

I. Tree height greater than 40 feet

   A. Mature or overmature sawtimber
      1. Crown coverage 10-39%
      2. Crown coverage 40-69%
      3. Crown coverage 70-100%

   B. Small sawtimber or pole stands
      1. Crown coverage 15-35%
      2. Crown coverage 45-65%
      3. Crown coverage 75-95%

   C. Two storied stand
      1. Crown coverage in overstory 10-39% and in understory 45-95%

II. Tree height less than 40 feet

   A. Seral brushfield
      1. Crown coverage less than 15%
      2. Crown coverage 15-35%
      3. Crown coverage 35-65%

   B. Cutover
      1. Clearcut
      2. Selective cut

III. Other

   A. Nonforest

APPENDIX C

Land types identified in the activity ranges and holding areas of 9 radio-collared elk. Descriptions and management implications for the land types listed here are documented by the USDA (1978).

A. Cool, moist and poorly drained: 22-5f, 23-5f, 25-5f, 30-5f, 31-5f, 32-4f, 32-5f, 32-3w, 33-4, 33-4f, 45-4f, 45-5f.

B. Cool, moist and well drained: 22-4, 22-5, 23-4, 23-5, 25-5, 30-4, 30-5, 31-5, 32-4, 32-5.

C. Dry and xeric: 22-3, 22-3f, 23-3, 25-3, 32-3, 32-3f, 33-1, 33-2, 33-3, 33-3f.

D. Dry and xeric breaklands: 60-3, 61-1, 61-2, 61-3, 62-2, 62-3, 63-3.

E. Moist breaklands: 60-5, .61-5, 61-5f, 62-4f, 62-5.

F. Stream bottoms (flood plains): 10.

G. Colluvial toeslopes and fans: 15.

H. Avalanche chutes: N.

I. Talus or skree: T 15, T 30-2, T 31-5, T 51, T 52, T 61-3, T 63-3.